Mail-Out MSC 99-25

NOTICE OF PUBLIC MEETING TO CONSIDER THE APPROVAL OF CALIFORNIA'S PORTABLE GASOLINE-CONTAINER EMISSIONS INVENTORY

The Air Resources Board (ARB) will conduct a public meeting at the time and place noted below to consider approving the portable gasoline-container emissions inventory.

DATE: September 23, 1999

TIME: 9:00 A.M.

PLACE: Air Resources Board
Board Hearing Room, Lower Level
2020 L Street
Sacramento, California

This item will be considered at a two-day meeting of the ARB commencing at 9:00 a.m., September 23, 1999, and may continue to September 24, 1999, if necessary. Please consult the agenda for this meeting, which will be available at least ten days before September 23, 1999, to determine the day on which this item will be considered.

This facility is accessible to persons with disabilities. If accommodation is needed, please contact the Clerk of the Board at (916) 322-5594; or, TDD (916) 324-9531, or (800) 700-8326 for TDD calls from outside the Sacramento area, by September 13, 1999.

INFORMATIVE DIGEST OF PROPOSED ACTION/PLAIN ENGLISH POLICY STATEMENT OVERVIEW

Proposed Actions: The ARB staff recommends the Board approve the proposed portable gasoline-container emissions inventory.

Background: California's emissions inventory for portable-gasoline containers is an estimate of the amounts of hydrocarbons emitted from thousands of such containers typically used to refuel residential-and-commercial off-highway vehicles and equipment. This is the ARB's first attempt at quantifying emissions from this source.

Section 39607(b) of the California Health and Safety Code has, for many years required the ARB to inventory emissions from sources of air pollution. The ARB has published inventories and updates for over 25 years. Improvements are made periodically to maintain and provide the most complete, accurate, and up-to-date inventory practicable.

VAILABILITY OF DOCUMENTS AND CONTACT PERSON

The ARB staff has prepared a Staff Report entitled “Public Meeting To Consider Approval Of California's Portable Gasoline-Container Emissions Inventory” (Staff Report). Copies of the Staff Report may be obtained from the California Air Resources Board, Public Information Office, 2020 L Street, Sacramento, California, 95814; or, telephone (916) 322-2990.

Copies of the Emissions Inventory for portable gasoline containers can be obtained by calling ARB’s Mobile Source Control Division at (626) 575-6800.

Further inquires regarding this matter should be directed to: Mark Carlock, Chief, Motor Vehicle Analysis Branch, Air Resources Board, 9528 Telstar Avenue, El Monte, California 91731; or, telephone at (626) 575-6608.

SUBMITTAL OF COMMENTS

This methodology was presented to the public during the June 29, 1999, workshop in El Monte. Staff has had on-going communications with interested parties. Staff invites comments regarding the inventory, or underlying methodology, prior to scheduled hearing.

The public may also present comments relating to this matter verbally or in writing to be considered by the Board. Written submissions must be addressed to: Clerk of the Board, Air Resources Board, P.O. Box 2815, Sacramento, California 95812; and, received no later than 12:00 noon, September 22, 1999; or, received by the Clerk of the Board at the hearing.

The Board requests, but does not require, that twenty copies of any written statement be submitted and that all written statements be filed at least ten days prior to the meeting. The ARB encourages members of the public to bring any suggestions for modification of the proposed action to the attention of staff in advance of the meeting.

CALIFORNIA AIR RESOURCES BOARD

Michael P. Kenny
Executive Officer

Date: September 8, 1999

California Environmental Protection Agency

AIR RESOURCES BOARD

PUBLIC MEETING TO CONSIDER APPROVAL OF CALIFORNIA'S PORTABLE GASOLINE-CONTAINER EMISSIONS INVENTORY

Air Resources Board
Mobile Source Control Division
September 1999

TABLE OF CONTENTS

LIST OF TABLES

PUBLIC MEETING TO CONSIDER APPROVAL OF CALIFORNIA'S PORTABLE GASOLINE-CONTAINER EMISSIONS INVENTORY

Recommendation.

The staff recommends the Air Resources Board (ARB or Board) approve the draft, statewide emissions inventory for portable-gasoline containers (gas cans). This inventory utilizes the latest data available to ensure that projections are accurate. The 1998-calendar-year emissions inventory, as presented in Table 1, represents the reference year from which all projections are made.

Table 1: Statewide Gas-Can Hydrocarbon-Emissions Inventory for 1998

Emission Type	Residential Emissions (tpd)	Commercial Emissions (tpd)	Total by Emission Type (tpd)
Permeation	6.8	0.4	7.2
Diurnal	59.1	5.2	64.3
Transport-Spillage	3.2	2.6	5.8
Spillage	-	-	6.9
Refueling-Vapor Displ.	-	-	2.3
Subtotal:	69.1	8.2	-
Total:	**-**		**86.5**

The staff will use the approved inventory to produce other types of inventories, such as inventories for past and future years, and inventories used for planning and air-quality modeling purposes. Health and Safety Code, Section 39607.3, requires the Board to review the emission inventory at a minimum of every three years. Staff intends to follow this three-year schedule; however, staff may seek Board review of portions of the inventory sooner than three years if significant changes with major policy implications are suggested by new information.

I. Introduction

The ARB is responsible for developing the hydrocarbon-emissions inventory associated with gas cans. Accordingly, a survey of gas-can usage was initiated for collecting real-world gas-can population, and end-usage information for estimating emissions. The survey results were used in estimating statewide commercial-and residential-gas-can populations, and for gaining a better understanding of typical usage and storage practices.

Gas-can emissions rates for various emissions modes (e.g., evaporation, permeation, etc.) occurring during typical usage were determined using diurnal evaporative and gravimetric test methods. The survey of population and usage were combined with the emissions test results to produce the inventory. This inventory will be used in estimating other inventories, such as those of past and future years, and for other purposes involving planning or air-quality modeling. The gas-can surveys and emissions test methods are discussed in the following sections.

A. Residential-Gas Cans.

1. Surveys.

Residential-gas-can information was solicited by mail from randomly selected California households and directly from various ARB staff. Appendix A is a copy of the residential-gas-can survey. Random California addresses were selected from the 1999 edition of the InfoUSA Inc. (InfoUSA) database. InfoUSA, of Omaha, NE, maintains nationwide databases of residential and commercial addresses. The ARB contracted with California Environmental Engineering, Santa Ana, CA, to prepare and execute the survey. Table 2 lists response data related to the Residential-Gas-Can Survey.

Table 2: Residential-Gas-Can Survey

Total Number of Solicitations by Mail	1,500
Undeliverable Mailed Solicitations	333
Effective Number of Solicitations by Mail	1,167
Number of Responses to Mailed Survey	261
Number of ARB Staff Solicitations	77
Number of ARB Staff Responses	63
Total Number of Survey Responses	324
Survey Response Rate	26%

Gas-can emissions are a function of the can material (i.e., plastic or metal) and the storage conditions. Gas cans are stored in either an "open" or a "closed" condition. An open condition, or system, exists when a can is stored with an open breathing (vent) hole and/or an uncapped main-filler opening or nozzle. A closed system exists when the vent hole is closed and the main-filler opening or spout is capped.

The residential-gas-can-survey reveals that 150 of the respondents have at least one gas can in their household (i.e., 46% of the respondents). Also, 70% of total residential-gas-can population is stored with fuel inside the gas cans; the other 30% of the population is comprised of gas cans that are stored empty. Other notable Residential-Gas-Can-Survey results are presented in Table 3.

Table 3: Residential-Gas-Can-Survey Results

Percentage of Households with at Least One Gas Can	46%
Number-of-Gas-Cans per Household	1.8
Percentage of Plastic-Gas Cans/Metal-Gas Cans	76%/24%
Weighted Average Gas Can Capacity (gal.)	2.34
Percentage of Gas Cans Stored With Fuel	70%
Weighted Average Stored Fuel Volume (% of Total Capacity)	49%
Percentage of Plastic-Gas Cans Stored Open/Closed	23%/53%
Percentage of Metal-Gas Cans Stored Open/Closed	11%/13%
Percentage of All Gas Cans Stored Open/Closed	34%/66%

2. Population.

The California State Department of Finance Demographic Unit estimates there were 11,127,621 occupied-household housing units in California as of January 1, 1998. This occupied-housing unit value is used as a surrogate to determine the residential portion of the total gas-can population. Occupied-housing estimates for California are separated for the various counties in the State, and are projected from the April 1, 1990 Census of Population and Housing.

The residential-gas-can population is calculated as follows:

$$Pop_R = (N)(A)(Count_R) \qquad \text{(Eq. 1)}$$

where: Pop_R = Statewide Residential-Gas-Can Population
N = Number of Occupied-Housing Units in California (11,127,621 on Jan. 1, 1998)
A = Percentage of Households with Gas Cans (46%)
$Count_R$ = Average Number of Residential-Gas Cans per Household (i.e., 1.8)

Substituting the appropriate values into Equation 1 yields a statewide population of **9,213,670** residential-gas cans for the 1998 calendar year.

3. Population-Growth Rate.

The 1990–98 housing unit data from the California Department of Finance is used to estimate future gas-can growth rates until the 2010 calendar year. These projected growth rates are normalized to the 1990 calendar year. The housing unit data were used to extrapolate values of future annual housing units in California until the 2010 calendar year. Table 4 lists housing growth rates for the 1990 to 2010 calendar years that are normalized to the 1990-calendar-year growth rate.

Table 4: Housing Growth Rates For 1990 – 2010 Calendar Years*

Year	Housing Units ($x10^6$)	Growth Rate (normal to 1990)	Year	Housing Units ($x10^6$)	Growth Rate (normal to 1990)
1990	10.38	1.000	2001	11.48	1.106
1991	10.52	1.014	2002	11.57	1.114
1992	10.64	1.025	2003	11.66	1.123
1993	10.74	1.034	2004	11.74	1.131
1994	10.82	1.042	2005	11.83	1.140
1995	10.90	1.050	2006	11.92	1.148
1996	10.97	1.057	2007	12.01	1.157
1997	11.04	1.064	2008	12.10	1.165
1998	11.13	1.072	2009	12.19	1.174
1999	11.23	1.081	2010	12.28	1.182
2000	11.39	1.097			

* Growth rates for 1990 through 1998 are based upon Department of Finance data. Rates for 1999 through 2010 are extrapolations.

4. Emissions.

Gas-can emissions are classified by five different emission processes:

a) Permeation;
b) Diurnal;
c) Transport;
d) Spillage; and,
e) Vapor Displacement During Equipment Refueling.

a) Permeation Emissions.

Permeation emissions are produced after fuel has been stored long enough in a can for fuel molecules to infiltrate and saturate the can material.

An average daily permeation-emission rate was derived from test data obtained from thirteen plastic-gas cans, and three metal-gas cans. The plastic-gas cans did not have a barrier-surface treatment. Each gas can was sealed with a metal-filled epoxy and an overcoat of a non-permeable two-part epoxy resin. Additionally, any plastic caps and plugs were replaced with metal ones whenever possible. Also, all secondary vents were plugged with brass fittings and coated with sealant. Lastly, the gas cans were leak checked and reworked as necessary. The gas cans were filled with certification test fuel (i.e., reformulated gasoline), and subjected to a diurnal-variable temperature profile in a sealed housing for evaporative determination unit (SHED). This temperature profile is the same as is currently required for on-highway motor-vehicle-evaporative emissions testing (ozone episode days), and is included as Appendix B. Gravimetric measure-ments were made of the gas cans after each 24-hour test period. The average daily permeation rate from a plastic-gas can (closed system) was calculated to be **1.57 grams per gallon per day** (g/gal-day). A permeation-emission rate for metal-gas cans was determined with similar test methods to be **0.06 g/gal-day**.

Statewide residential-gas-can-permeation emissions are computed as follows:

$$HC_{PR} = \Sigma \left[(Pop_R)(S)(EF_P)(B_R)(Size_R)(Level) \right] \qquad \text{(Eq. 2)}$$

where:
- HC_{PR} = Permeation Emissions in tons per day (tpd)
- Pop_R = Statewide Residential-Gas-Can Population
- EF_P = Appropriate Permeation-Emission Factor (g/gal-day)
- S = Percentage of Gas Cans Stored with Fuel (70%)
- B_R = Percentage of Cans Stored in Closed Condition with respect to Material (Plastic 53%; Metal 13%)
- $Size_R$ = Weighted Average Capacity of Residential-Gas Cans (2.34 gal.)

Level = Weighted Average Amount of Stored Fuel (49%)

Substituting the appropriate values into Equation 2, summing the resultant products, and converting grams to tons (i.e., $9.08(10^5)$ grams per ton), produces a statewide total of **6.8 tpd** of residential-plastic-gas-can-permeation emissions. Similarly, a permeation-emissions total for residential-metal-gas-cans was determined to be **0.1 tpd**.

b) Diurnal Emissions.

Diurnal emissions result when stored fuel vapors escape to the outside of a gas can through any possible openings while the gas can is subjected to the daily cycle of increasing and decreasing ambient temperatures (See Appendix B). Diurnal emissions are dependent on the closed- or open-storage condition of a gas can. Accordingly, emissions rates were determined for both conditions.

Closed-System. Plastic-gas-can test data were gathered from two 2-gallon-8-ounce, and two five-gallon, size gas cans. These gas cans were filled with certification-test fuel to one-half of the total capacity. One-half of the gas-can capacity approximates the weighted average of stored fuel volume of 49% (See Table 2). The cans were subjected to a diurnal-variable temperature profile in a shed (See Appendix B for the temperature profile). An average diurnal-emission rate was first calculated using each individual gas-can average daily-emission rate. The average-daily plastic-gas-can permeation rate of 1.57 g/gal-day (determined earlier for closed systems) was then subtracted from that value to yield the resultant diurnal-emission rate for plastic, closed-system gas cans of **1.38 g/gal-day**. Similar diurnal-SHED tests of three metal-gas cans produced an average daily emission rate of **0.44 g/gal-day**.

Open-System. Plastic-gas-can test data were gathered from one five-gallon, and three 2-gallon-8-ounce, size gas cans. Each gas can was weighed, filled with test fuel to various fractions of their total capacities, and weighed again. The gas cans were then stored with open vent and breathing holes. Each gas can was weighed after each subsequent 24-hour period for sixteen consecutive days. The average diurnal-emission rate over the test period was **21.8 g/day**. Note that this diurnal-emission rate is applicable for both plastic- and metal-gas cans that are stored in an open condition.

Diurnal emissions from both open- and closed-system-residential-gas cans are calculated as follows:

$$HC_{DR} = (Pop_R)(S)(EF_D)(B_R)(Size_R)(Level) \quad \text{(Eq. 3)}$$

where: HC_{DR} = Diurnal Emissions (tpd) for Residential-Gas Cans with respect to Storage Condition (Open or Closed) and Material (Plastic or Metal)

Pop_R = Statewide Residential-Gas-Can Population
S = Percentage of Gas-Can Population Stored with Fuel (70%)
EF_D = Appropriate Diurnal-Emission Factor with respect to Storage Condition and Material (g/gal-day or g/day)
B_R = Percentage of Gas-Can Population with respect to Storage Condition and Material (see Table 3)
$Size_R$ = Weighted Average Capacity of Residential-Gas Cans (2.34 gal.)
Level = Weighted Average Amount of Stored Fuel (49%)

Substituting the appropriate values into Equation 3, and performing the conversion to tons, yields a statewide total residential-gas-can-diurnal emission amount of **59.1 tpd** for the 1998 calendar year. Specific diurnal emissions with respect to storage conditions and materials are listed in Table 5.

Table 5: Residential-Gas-Can-Diurnal Emissions for 1998 Calendar Year

Material	Stored Condition	% of Population	Emission Factor (g/gal-day)	Emission Factor (g/day)		Emissions (tpd)
Plastic	Open	23	-	21.8		35.6
Plastic	Closed	53	1.38	-		6.0
					Subtotal:	41.6
Metal	Open	11	-	21.8		17.0
Metal	Closed	13	0.44	-		0.5
					Subtotal:	17.5
					Total:	**59.1**

c) Transport-Spillage Emissions.

Transport-spillage emissions arise when fuel escapes (e.g., spills, etc.) from gas cans that are in transit. The transport-emission-spillage factor was determined from data provided by the U. S. EPA's fuel transport spillage survey of hydrocarbon

losses from lawn and garden equipment[1]. Analysis of this data revealed that the emission rates for a gas can (i.e., pump-to-pump losses) were **23.0 grams per gas-can-refill-at-the-pump** (g/refill) for a closed system, and **32.5 g/refill** for an open system. Analyses of responses from the Residential-Gas-Can survey showed that the frequency of average residential-gas can-refills at the pump is 6.4 refills per year (refill/year) per can, or **0.0174 refill/day** per can. Accordingly, residential-transport-spillage emissions are determine as:

$$HC_{TR} = (Pop_R)(S)(Refill_R)(EF_T)(B_R) \qquad \text{(Eq. 4)}$$

where:
- HC_{TR} = Residential-Gas-Can-Transport-Spillage Emissions (tpd)
- Pop_R = Statewide Residential-Gas-Can Population
- S = Percentage of Gas Cans Stored with Fuel (70%)
- $Refill_R$ = Average Number of Residential-Gas-Cans-Pump-Refills per Day per Can (0.0174 refill/day)
- EF_T = Transport-Emission Factor with respect to Storage Condition (g/refill)
- B_R = Percentage of Gas Cans with respect to Storage Condition and Material (see Table 3)

Substituting the appropriate values into Equation 4, and converting grams to tons, yields a statewide total residential-gas-can-transport-spillage emission value of **3.2 tpd**. Individual emission values are listed in Table 6.

B. Commercial-Gas Cans.

1. Surveys.

Commercial-gas can usage and storage information was solicited by ARB staff directly from various Northern and Southern California businesses. Appendix C is a copy of the Commercial-Gas-Can Survey. Targeted businesses included agricultural, automotive club and tow services, service stations, lawn and garden maintenance services, general contractors, and construction and rental yards. On-site survey

Table 6: Residential-Gas-Can-Transport-Spillage Emissions for 1998

[1] Appendix C, "OPEI/CAAC Spillage and Evaporative Hydrocarbon Losses for Lawn and Garden Applications," June 16, 1993.

Material	Stored Condition	% of Population	Emission Factor (g/refill)		Emissions (tpd)
Plastic	Open	23	32.5		0.9
Plastic	Closed	53	23.0		1.5
				Subtotal:	2.4
Metal	Open	11	32.5		0.4
Metal	Closed	13	23.0		0.4
				Subtotal:	0.8
				Total:	**3.2**

interviews and observations of gas-can usage in typical business activities were conducted in Southern California. Either an on-site or telephone interview was conducted for a business in Northern California. As shown in Table 7, the response rate for the Commercial-Gas-Can Survey was 94%.

Table 7: Commercial-Gas-Can Survey

Total Number of Solicitations	161
Incomplete Responses	9
Total Number of Survey Responses	152
Survey Response Rate	94%

The Commercial-Gas-Can Survey indicates that 80% of the businesses surveyed have at least one gas can. Other significant survey results are presented in Table 8.

Table 8: Commercial-Gas-Can-Survey Results

Percentage of Businesses with at Least One Gas Can	80%
Gas Cans per Businesses	6.9
Weighted Average Gas Can Capacity (gal.)	3.43
Percentage of Plastic-Gas Cans/Metal-Gas Cans	72%/28%
Percentage of Plastic-Gas Cans Stored Open/Closed	39%/33%
Percentage of Metal-Gas Cans Stored Open/Closed	10%/18%
Percentage of All Gas Cans Stored Open/Closed	49%/51%

2. Population.

The populations of commercial-gas cans held by businesses were determined using the InfoUSA database. Specific businesses that are expected to utilize gas cans in their normal operations were identified within various industrial classifications (e.g., agricultural services, general building services, etc.). Summing up the individual populations of each business group gives an estimate of the total statewide population of businesses using gas cans.

The commercial-gas-can population is calculated as follows:

$$Pop_C = (N_C)(Count_C) \quad \text{(Eq. 5)}$$

where:
- Pop_C = Statewide Commercial-Gas-Can Population
- N_C = Number of Occupied Businesses in California (84,712 in 1998)
- $Count_C$ = Average Number of Gas Cans per Business (6.9)

Substituting the appropriate values into Equation 5 yields a commercial-gas-can population of **584,513** for the 1998 calendar year.

3. Emissions.

a) Permeation Emissions.

Permeation-emission rates for commercial-gas cans are assumed to be the same as those for residential-gas cans. Accordingly, the commercial-gas-can permeation-emission rate for a plastic-gas can is 1.57 g/gal-day, and for a metal-gas

can is 0.06 g/gal-day. The commercial survey did not determine either the average amount of fuel stored in commercial-gas cans or the number of commercial-gas cans that are stored empty. Therefore, the residential-gas-can values of these parameters are used in the commercial-gas can calculations.

Statewide commercial-gas-can-permeation emissions are computed as follows:

$$HC_{PC} = \Sigma \left[(Pop_C)(S)(EF_P)(B_C)(Size_C)(Level) \right] \qquad \text{(Eq. 6)}$$

where:
- HC_{PC} = Permeation Emissions (tpd)
- Pop_C = Statewide Commercial-Gas-Can Population
- EF_P = Appropriate Permeation-Emission Factor (g/gal-day)
- S = Percentage of Gas Cans Stored with Fuel (70% for Residential Survey)
- B_C = Percentage of Applicable Gas Cans Stored in Closed Condition
- $Size_C$ = Weighted Average Capacity of Commercial-Gas Cans (3.43 gal)
- Level = Weighted Average Amount of Stored Fuel (49% from Residential Survey)

Substituting the appropriate values into Equation 6, summing the resultant products, and converting grams to tons, gives a commercial-gas-can statewide permeation-emissions total of **0.39 tpd** for plastic-gas cans, and **0.01** tpd for metal-gas cans.

b) Diurnal Emissions.

Diurnal-emissions rates for commercial-gas cans are expected to be the same as for residential-gas cans. Therefore, the commercial-gas-can diurnal-emissions rate for a closed, plastic-gas can is 1.38 gm/gal, and for an open, plastic-gas can is 21.8 g/gal-day. The diurnal-emissions rate for a closed, metal-gas can is 0.44 g/gal-day; the rate for an open, metal-gas can is 21.8 g/gal-day.

The amount of diurnal emissions from both open- and closed-system commercial-gas cans is calculated as follows:

$$HC_{DC} = (Pop_C)(S)(EF_D)(B_C)(Size_C)(Level) \qquad \text{(Eq. 7)}$$

where:

HC_{DC} = Diurnal Emissions (tpd) for Commercial-Gas Cans with respect to Storage Condition (Open or Closed) and Material (Plastic or Metal)

Pop_C = Statewide Commercial-Gas-Can Population

EF_D = Appropriate Diurnal-Emission Factor with respect to Storage Condition and Material (g/gal-day or g/day)

S = Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)

B_C = Percentage of Gas Cans with respect to Storage Condition and Material (see Table 8)

$Size_C$ = Weighted Average Capacity of Commercial-Gas Cans (3.43 gal.)

Level = Weighted Average Amount of Stored Fuel (49% from Residential Survey)

Substituting the appropriate values into Equation 7, and converting grams to tons, yields the various 1998-calendar-year commercial-gas-can-diurnal-emission values listed in Table 9.

c) Transport-Spillage Emissions.

Transport-Spillage emissions factors for commercial-gas cans are expected to be the same as those for residential-gas cans: 23.0 g/refill per can for a closed system, and 32.5 g/refill per can for an open system. The frequency of gas-can refills at the pump for lawn-and-garden equipment is expected to be different than for all of the other types of commercial equipment. This is due to the higher level of activity for commercial lawn-and-garden equipment; hence, this equipment is expected to be refueled more often than is other commercial equipment. Accordingly, the frequency of average commercial lawn-and-garden-equipment gas-can refills at the pump is derived from the U. S. EPA's fuel transport spillage survey of hydrocarbon losses from lawn and garden equipment data. The analysis of this data results in a frequency of 351 refill/year per can (0.964 refill/day).

The 1998-calendar-year frequency of non-lawn-and-garden-equipment commercial-gas-can refills at the pump is derived as follows:

$$Refill_C = \left[\frac{(\Sigma \text{ Fuel})}{(Size_C)(POP_{NON})(S)} \right] \qquad \text{(Eq. 8)}$$

Table 9: Commercial-Gas-Can-Diurnal Emissions for 1998 Calendar Year

Material	Stored Condition	% of Population	Emission Factor (g/gal-day)	Emission Factor (g/day)	Emissions (tpd)
Plastic	Open	39	-	21.8	3.8
Plastic	Closed	32	1.38	-	0.3
				Subtotal:	4.1
Metal	Open	10	-	21.8	1.0
Metal	Closed	18	0.44	-	0.1
				Subtotal:	1.1
				Total:	**5.2**

where:

$Refill_C$ = Average Number of Non-Lawn-and-Garden Equipment Commercial-Gas-Cans Pump Refills per Day per Can (refill/day)

Fuel = Non-Lawn-and-Garden Equipment Fuel Consumption (gal/day) for 1998 (total summation equals 150,342 gal/day; See Appendix D)

$Size_C$ = Weighted Average Capacity of Commercial-Gas Cans (3.43 gal/can-refill)

POP_{NON} = Statewide Commercial-Gas-Can Population with respect to Non-Lawn-and-Garden Businesses (520,417 for 1998)

S = Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)

Substituting the appropriate values into Equation 8 yields a frequency of 0.12 refill/day. The commercial-transport-spillage emissions are determine as:

$$HC_{TC} = (Pop_C)(S)(B_C)(Refill_C)(EF_{TC}) \quad \text{(Eq. 9)}$$

where:

HC_{TC} = Commercial-Gas-Can-Transport-Spillage Emissions (tpd)

Pop_C = Statewide Commercial-Gas-Can Population

S = Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)

B_C = Percentage of Gas Cans with respect to Storage Condition and Material (see Table 7)

$Refill_C$ = Average Number of Gas-Cans Pump Refills per Day per Can (0.964 for lawn & garden equipment or 0.12 for non-lawn & garden)

EF_{TC} = Transport-Spillage Emission Factor (g/refill) with respect to Storage Condition

Substituting the appropriate values into Equation 9, and performing the conversion from grams to tons, yields the values listed in Table 10.

Table 10: Commercial-Gas-Can-Transport-Spillage Emissions for 1998

Equipment	Material	Stored Condition	% of Population	Emission Factor (g/refill)		Emissions (tpd)
Lawn	Plastic	Open	39	32.5		0.6
Lawn	Metal	Open	10	32.5		0.2
Lawn	Plastic	Closed	33	23.0		0.4
Lawn	Metal	Closed	18	23.0		0.2
					Subtotal:	1.3
Non-Lawn	Plastic	Open	39	32.5		0.6
Non-Lawn	Metal	Open	10	32.5		0.2
Non-Lawn	Plastic	Closed	33	23.0		0.4
Non-Lawn	Metal	Closed	18	23.0		0.2
					Subtotal:	1.4
					Total:	**2.6**

C. Spillage Emissions During Equipment Refueling.

Spillage emissions are produced when fuel is dispensed from a gas can to an equipment/vehicle fuel tank, another gas can, etc., and fails to either be delivered into the intended reservoir or to remain inside the reservoir. Spillage data provided by the Outdoor Power Equipment Institute (OPEI) in conjunction with the U. S. EPA's NEVES report[2] indicate that the spillage-emission rate for equipment refills from a gas can is 17 grams per refill per equipment unit. This estimate assumes that every refill results in a replenishment of the fuel tank's entire capacity. The spillage-emission rate is applied to only equipment or vehicles that are typically fueled from a gas can (e.g., lawn care equipment, sometimes recreational equipment, etc.), and not typically from a pump. Appendix E lists the various equipment categories by their applicable horsepower ranges with respect to the fractional mode of refueling (i.e., refueling from a gas can vs. from a pump).

The amount of daily spillage emissions from all applicable residential- and commercial-gas cans is calculated as follows:

$$HC_S = \Sigma \left\{ \left[\frac{(Fuel)(Spill)}{(Tank)} \right] (Con) \right\} \qquad \text{(Eq. 10)}$$

where:
- HC_S = Daily Spillage Emission from All Gas Cans (tpd)
- Fuel = Applicable Equipment/Vehicle Type Fuel Consumption (gal/day)
- Spill = Spillage-Emission Rate per Refill of Gas Can-Refueled Equipment/Vehicles (17 g/refill)
- Tank = Applicable Equipment/Vehicle Fuel-Tank Capacity (gal/refill)
- Con = Frequency of Refuels (per day) with respect to Equipment/Vehicle (none, always, or fraction of always – See Appendix E)

The specific equipment and vehicle fuel-consumption values with respect to the applicable equipment or vehicle horsepowers were determined by the ARB's Off-Highway Emissions Estimate Model (OFFROAD)**.** The various equipment and vehicle fuel-tank capacities were provided by either the gas can manufacturers or the U. S. EPA. Substituting the appropriate values into Equation 10, summing up the individual results, and converting grams to tons, yields a combined residential-and-commercial-spillage emissions amount of **6.9 tpd** for the 1998 calendar year.

D. Refueling-Vapor Displacement.

[2] "Nonroad Engine and Vehicle Emission Study – Report," U. S. Environmental Protection Agency, November 1991.

The refueling-displacement-vapor emissions result when fuel vapor is displaced from equipment and vehicle fuel tanks, gas cans, etc., by fuel dispensed from gas cans. The NEVES report of refueling emissions presented a formula to compute the refueling-vapor-displacement-emission factor. This formula is:

$$DISP = [-5.909 + (0.0884)(TD) + (0.485)(RVP)] \qquad \text{(Eq. 11)}$$

where:
- DISP = Daily Spillage-Emission Rate for All Gas Cans (g/gal)
- TD = Temperature (°F) of the Dispensed Fuel (ambient temperature)
- RVP = Reid Vapor Pressure of Dispensed Fuel (psi)

Substituting the appropriate values into Equation 11 yields a refueling vapor-displacement emission rate of **4.52 g/gal**. The amount of daily refueling vapor-displacement emissions from all applicable residential-and commercial-gas cans is calculated as follows:

$$HC_{DISP} = \Sigma \left\{ (DISP)(Fuel)(Con) \right\} \qquad \text{(Eq. 12)}$$

where:
- HC_{DISP} = Total Refueling-Vapor-Displacement Emissions from All Gas Cans (tpd)
- DISP = Refueling Vapor Displacement Emission Rate (4.52 g/gal)
- Fuel = Applicable Equipment/Vehicle Type Fuel Consumptions (gal/day)
- Con = Frequency of Refuels (per day) with respect to Equipment/Vehicle (none, always, or fraction of always – See Appendix D)

As with the spillage-emission-factor calculation, the vapor-displacement-emission rate is applied only to equipment or vehicles that are typically fueled from a gas can, and not from a pump dispenser. The specific equipment and vehicle fuel-consumption values

used in the calculations were produced by OFFROAD. Substituting the appropriate values into Equation 12, summing up the individual products, and converting grams to tons, yields a combine residential and commercial refueling-vapor-displacement-emissions amount of **2.3 tpd** for the 1998 calendar year.

E. Summary of Results.

Table 11 lists the total statewide 1998-calendar-year residential and commercial gas-can emissions by each type of emission mode. Table 12 presents a breakdown of the 1998-calendar-year gas-can populations. Lastly, Table 13 lists the estimated statewide gas-can emissions for the 2007 calendar year; Table 14 lists for 2010.

Table 11: Statewide Gas-Can Emissions for 1998 Calendar Year

Emission Type	Residential Emissions (tpd)	Commercial Emissions (tpd)	Total by Emission Type (tpd)
Permeation	6.8	0.4	7.2
Diurnal	59.1	5.2	64.3
Transport-Spillage	3.2	2.6	5.8
Spillage	-	-	6.9
Refueling-Vapor Displ.	-	-	2.3
Subtotal:	69.1	8.2	-
Total:	**-**	**-**	**86.5**

Table 12: Statewide Gas-Can Populations for 1998 Calendar Year

Type	Total Population	Stored w/Fuel
Residential	9,213,670	6,449,569
Commercial	584,513	409,159
Total:	**9,798,183**	**6,858,728**

Table 13: Statewide Gas-Can Emissions for 2007 Calendar Year*

Emission Type	Residential Emissions (tpd)	Commercial Emissions (tpd)	Total by Emission Type (tpd)
Permeation	7.4	0.4	7.8
Diurnal	63.8	5.6	69.4
Transport-Spillage	3.5	2.9	6.4
Spillage	-	-	8.0
Refueling-Vapor Displ.	-	-	2.6
Subtotal:	74.6	8.9	-
Total:	**-**	**-**	**94.2**

*Estimates for Permeation, Diurnal, and Transport-Spillage emissions are based on the projected growth in the gas-can population. The Spillage and Refueling-Vapor Displacement emissions are based on projected growth in off-road equipment per the OFFROAD model.

Table 14: Statewide Gas-Can Emissions for 2010 Calendar Year*

Emission Type	Residential Emissions (tpd)	Commercial Emissions (tpd)	Total by Emission Type (tpd)
Permeation	7.5	0.4	7.9
Diurnal	65.2	5.8	71.0
Transport-Spillage	3.6	2.9	6.5
Spillage	-	-	8.3
Refueling-Vapor Displ.	-	-	2.6
Subtotal:	76.3	9.1	-
Total:	**-**	**-**	**96.3**

*Estimates for Permeation, Diurnal, and Transport-Spillage emissions are based on the projected growth in the gas-can population. The Spillage and Refueling-Vapor Displacement emissions are based on projected growth in off-road equipment per the OFFROAD model.